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Avantgarde Acoustic Zero 1 Pro Loudspeaker

Before I turn to the subject of this review—Avantgarde Acoustic’s fabulous, \$16,000, powered, digitally optimized, virtually plug ’n’ play Zero 1 horn loudspeaker system, which, to spill the beans in the very first sentence, is far and away the most ingenious and sonically successful compact horn loudspeaker I’ve ever heard (and in many ways one of the freshest, most brilliantly engineered, and strikingly styled loudspeakers of any kind I’ve come across

in years)—I’m going to talk a bit about horns and my past experience with them. Those of you who feel like I’m taking the long way around the barn, can skip to the chase on page 130 (column two). Those of you who haven’t have had much experience with horn loudspeakers may want to read on.

As was the case with subwoofers (until the JLAudio e110 showed up just a few months ago), I’ve taken a “been there, done that” attitude toward horn loudspeakers for the past decade or two. I gave them a lengthy shot around the close of



Modern Masterpiece

Jonathan Valin

the past millennium—using Avantgarde Acoustic’s four-way Trio Compact horn loudspeaker system as my reference for two-and-a-half years. By the end of that time I’d lost sight of all the things that horns do better than other speakers (and they do a whole bunch of things better) in the light of all the things they do worse.

Chief among the original Trio Compact’s shortcomings was its inability to consistently turn the one trick I consider most important in any stereo component: disappear as a sound source.

Despite its incomparable transient speed, still unexcelled dynamic range, near-stat-like resolution and tone color, and ability to make certain hard-to-realistically-reproduce instruments and ensembles (such as grand piano and symphony orchestra) seem astonishingly “there,” sooner or later the Trio ended up betraying its presence by sounding like three separate tubes yoked to an inferior cone subwoofer. In other words, the Trio lacked the seamless driver-to-driver coherence that is one of the chief prerequisites of a “disappearing act.”

Avantgarde Acoustic Zero 1 Pro Loudspeaker



Of course, the Trio Compacts I owned were the very first iterations of Avantgarde's strikingly beautiful spherical-horn system, and a good deal has changed in the German company's thinking over the last twenty years (as the Zero 1 and my recent experience with the latest Trio/Basshorn system attest). Even at that, I've never forgotten those occasions on which the original Trio shone. No other speaker I've used as a reference has combined speed of attack, dynamic range, resolution, and beautiful tone color (especially when it was driven by SET amps) in quite the same measures as the Avantgarde Trio Compact. But then no other speaker has had the advantages of horn-loading.

The most mature loudspeaker technology and quite literally the first, horns benefit and to some extent suffer from the enormous amount of research devoted to their design. According to horn guru Dr. Bruce Edgar, there is still a lack of clear consensus about how to build a proper horn (and any number of wrong ideas and dead ends in the literature—not surprising given that horns have been studied and written about for better than a century). What isn't in doubt, and never has been, are a horn's manifold intrinsic strengths, the first and foremost of which is much higher efficiency.

A horn is able to provide higher SPLs (and greater transient speed and dynamic range) at a given listening position and given wattage for two reasons. First, the horn's tapered shape increases the directivity of the driver's wavelaunch, concentrating and intensifying the sound rather in the same way that a flashlight's beam becomes brighter and more intense when that beam is focused rather than diffused. (The horn's tapered shape and consequent highly-directional wavelaunch has the substantial additional benefit of reducing the deleterious effects of room

reflections, since, unlike conventional cone or dome drivers or planar dipoles, horns don't radiate substantial amounts of their energy hemispherically or in a figure-eight pattern.)

Second, a horn plays louder, with greater speed and dynamic range, because it more efficiently couples its driver to the air of the room via a phenomenon known as "acoustic impedance matching." Like a megaphone, a horn constricts the area and volume of air that the driver (or human voice, in the case of a megaphone) works "into." As a result of this constriction, the acoustic impedance of the air trapped in the horn's throat (the narrowest part of the horn immediately in front of the driver) comes much closer to the high acoustic impedance of the driver's diaphragm. (When the impedance—the electrical, mechanical, magnetic, or thermal opposition of a system to the flow of energy—of a source and a load are matched, power is transferred maximally.) This superior impedance matching of air and driver allows a horn to generate higher pressures from smaller movements of its diaphragm. Moreover, as the horn's tapered shape gradually increases in area toward its mouth (the widest part of the horn that opens onto the listening room), those high-pressure soundwaves generated in the horn's throat by miniscule vibrations of the driver's diaphragm grow lower in pressure and progressively larger in displacement as they travel down the horn's length, allowing them to couple more efficiently to the low-impedance air of the listening room. A horn-loaded driver is in many ways the ideal acoustical-energy delivery system, typically providing ten times more sound power than a cone speaker would from the same amplifier output.

But playing much louder with much less amplifier power is only one of a horn loudspeaker's inherent virtues. Because



the diaphragm of the driver attached to the horn works so much more efficiently (thanks to increased directionality and acoustic impedance matching), the driver itself has *far* less work to do than a non-horn-loaded driver, such as a typical direct-radiating cone or membrane that has to move air without the benefit of impedance matching. The horn-loaded driver's much smaller excursions mean much lower inertia and distortion, which translate into a blur-less clarity, electrifying speed and pace, and sensational dynamic range that have to be heard to be fully appreciated. No other kind of loudspeaker can move air as efficiently as a horn speaker does—and on powerful instruments or large ensembles the effect can be startlingly realistic.

That's the inherent positive side of horns. The negative side, unfortunately, is also built into them.

Because of horn-loading, the very-high-pressure soundwaves generated in the horn's throat are literally reflected off the throat walls. Any irregularities in those walls (any bumps or dips or material or structural resonances) and any high-Q resonances in the drivers themselves (when a compression driver is run out-of-passband, it decouples from the horn, particularly in its lower frequencies, generating distortion) will add a characteristic turbulence to the signal that ends up being amplified along with the music. The sonic result of this added distortion is the “cupped hands” or

“horn coloration” that you typically hear on P.A. systems—like someone talking with his hands so tightly cupped around his mouth that they slightly pinch his nose. Such colorations also have the psychoacoustic side effect of localizing the drivers, making them sound even more like individual tubes than like a coherent loudspeaker system.

Additionally, though properly designed horns are inherently phase-correct transducers, the various resonances of the materials the horns are made of and the necessarily (because of the physical size of the tubes) much wider disposition of the drivers in space vis-à-vis each other can make overall time/phase/frequency coherence a dicey proposition. The small cone and dome drivers of a latter-day dynamic loudspeaker are typically located to the exact micrometer on a baffle—to ensure a time/phase/frequency-coherent wavelaunch. Though the positioning of drivers in a horn system is also mathematically precise, the horns'

physical size, their inherent resonances, and, paradoxically, their more highly directional wavelaunch tend to work against such coherence at normal seating distances, once again making you increasingly aware that you're listening to separate drivers playing in separate frequency ranges.

Nowhere is this sense of incoherence more prominent than in the bass, which in many contemporary horn systems (such as my

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Avantgarde Acoustic Zero 1 Pro Loudspeaker

Avantgarde Trio Compact from the late nineties) is often handled by a conventional cone subwoofer. Why not use a separate horn for the bass, you ask? Because the long wavelengths of bass frequencies would necessitate a horn with a mouth the size of a three-or-four-car garage! (Back in the day, Nelson Pass actually turned a large garage in the hills above the Berkeley campus into a horn-loaded woofer, which played so loudly and went so deep that cops from all over the valley were regularly called to his residence to tell him to, uh, “turn it down.”)

The other solution to reproducing bass frequencies in a horn system is via a so-called folded horn—a long, zigzag-shaped, flaring duct built inside a cabinet into which a woofer fires. The path-length and flare-rate of the duct determine the low-frequency cut-off point of the horn, although the resonances of the cabinet and of the duct itself can result in the same horn-like colorations in the bass that you often hear in a horn speaker’s mids and treble. (Avantgarde currently uses a superior version of a quarter-wave folded horn in its Basshorn system, but that’s a story for another day.)

Seamlessly matching a cone subwoofer to an ultra-fast, ultra-clean, ultra-high-sensitivity horn system via conventional means is about as tough a task as you can set yourself in high-end audio. In fact, until I heard the Avantgarde Zero 1s I would’ve said it was impossible—a fool’s errand. Even the best direct-radiating cone subs will seem slightly sluggish off-the-line compared to the super-charged engine of the horn-loaded drivers. Plus, as is the case with any subwoofer, you have the extremely tricky issue of crossover slope/point to negotiate, plus the little matter of dispersion pattern, which is highly directional and relatively room-independent in a horn and (down to a certain frequency) omnidirectional and highly room-dependent in a sub.

My view of a horn system’s strengths and weaknesses has not changed much since the Trio Compact days. Oh, I’ve certainly heard great-sounding horn systems at various trade shows, including several in Munich just a few months ago. (And once again I’m not denying the unique virtues of horn-loaded drivers.) But I’ve also invariably heard traces of the “cupped hands” colorations and driver-to-driver incoherence that eventually wore me down and out when I owned the original Avantgardes. (I guess I should also note that because of the various phase, time, and frequency-response issues I’ve already mentioned and the sheer aggregate size of their wavelaunch, horn loudspeakers don’t image with great precision—nor, since they don’t disperse their sound hemispherically the way point-source direct-radiators do, do they typically soundstage “outside the box.” Although the severity of these problems depends on the design of the horn and the level it is played at, certain horns can be as much the poster children for “six-foot-wide” voices and violins and guitars as vintage planars were.)

So...it would seem that to live with a horn loudspeaker system’s great virtues you must also live with a horn loudspeaker system’s great flaws. This is certainly what I’ve believed for the past two decades. And then along came the Avantgarde Acoustics Zero 1s.

What’s different about the Zero 1s? In a word, everything.

These extremely ingenious speakers were truly designed on a blank slate. They make brilliant use of Digital Age technologies (developed for Avantgarde by Danish DSP guru Thomas Holm) to solve many of the intrinsic problems of horn loudspeakers, and in particular those issues that have been the biggest stumbling blocks for me—coherence and coloration. That they succeed in doing so to an extent I wouldn’t have believed possible (had I not heard them) is a wonderment. It is also, I confess, the best argument I’ve yet come across for using DSP to optimize the performance of a transducer.

What exactly are Zero 1s? They are compact, self-powered (active), high-sensitivity (104dB/1W/1m), three-way loudspeakers with a spherical-horn-loaded tweeter, a spherical-horn-loaded midrange, and a direct-radiating cone woofer. All three drivers are housed in a stunning Bauhaus-like enclosure made of a sandwich of polyurethane foams—one of the coolest-looking objects of audio art I’ve seen since, well, the Avantgarde Trios. Why did Avantgarde use this foam-sandwich material? Because the random distribution of randomly-sized bubbles in the center section of the sandwich makes the entire structure highly non-resonant and self-damping, plus these plastics can be injected-molded to order, which is precisely what Avantgarde

does. Internal bracing is cast into the front and rear casings of the Zero 1 enclosures, while the spherical horns are molded into the baffle, recessed into it in concave fashion, rather than projecting out in front of it. (Polyurethane’s ultra-smooth, non-resonant surfaces make an excellent material for a horn, where smoothness, particularly in the throat area, is essential to help prevent turbulence and distortion.)

Each of the Zero 1’s three drivers is powered by its own built-in amplifier. Both the tweeter and the midrange use 50W, zero-negative-feedback, Class A solid-state amps, the power supplies of which are identical to the power supply in Avantgarde’s flagship XA amplifier. A 400W Class D amplifier is used to power the woofer. (The amps were designed by Avantgarde’s resident engineering genius, Matthias Ruff.) All of the amplifiers are directly connected to the drivers’ voice coils, without any power-robbing, phase-shifting, passive crossover parts (resistors, coils, caps) in the signal path.

How do you eliminate crossovers in a three-way loudspeaker? Well, that brings us to the niftiest part of this incredibly nifty loudspeaker. As previously noted, Avantgarde commissioned Thomas Holm to develop a digital crossover network using 66-bit FPGAs (Field-Programmable Gate Arrays—essentially computer chips that are designed and programmed to order)—and FIR (Finite Impulse Response) algorithms to optimize the entire speaker’s amplitude, impulse, and phase response from about 30Hz (the cutoff frequency of the woofer) to about 20kHz (the cutoff frequency of the tweeter) within a “listening bubble” of about 2m to 4m, with a listening position of approximately 3m being ideal. (A digital crossover is capable of complex,

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progressive slopes running from 6dB/octave at crossover to 100dB/octave at a driver's cut-off point; an analog X/O simply couldn't manage this.)

The "price" of all this digital optimization is that you have to come into the Zero 1 via digital or digitized sources, which, after DSP filtration, are converted to analog just ahead of the power amplifiers via three 24-bit/352.8kHz Burr-Brown DACs. The speakers (well one speaker—for which see the sidebar on setup) come with a wide variety of digital inputs (one USB, one TosLink, two SPDIF, and one AES/EBU), all of which (save for the USB) are capable of handling 24-bit/192kHz high-resolution music files. (No—the Zero 1 won't do DSD or double-DSD... yet.) The Zero 1 can also be sourced wirelessly via AirPort Express and offers the option of an A-to-D converter board for those of you (like me) who want to play back LPs or tapes.

With amplification built in, all you have to add to the Zero 1s to make them play is a source and a USB or AES/EBU or SPDIF or TosLink cable. (And you don't even have to add a cable if you choose to source them via an AirPort Express.)

Provided that the speaker's rake angle (which affects the height and directivity of the tweeter), distance from the rear wall, and toe-in are set properly (for which, see "Setting Up the Avantgarde Zero 1s"), Avantgarde claims that the Zero 1s will be virtually plug 'n' play in any room, doing their DSP-optimized magic regardless of the listening room's shape or size or damping. (Remember that because of their intense directionality horn-loaded drivers don't excite room nodes like wide-dispersion point-source drivers, although conventional woofers, such as the one in the Zero 1, can and do.)

To test Avantgarde's bold claim, as soon as they arrived I plopped the Zero 1s down in my living room—an irregularly-shaped space with fourteen-foot ceilings and no room treatment of any kind (I never listen in this room). After attaching their bases and fiddling with the Zero 1s' rake, toe-in, and location vis-à-vis the rearwall as per the instruction manual, I started playing music via a Mac computer connected to Berkeley Audio's superb USB-to-AES converter. To my amazement—and that of my wife Kathy, who, even after all these years, is the least-audiophile person I know—the sound was remarkable. To top this off, Kathy was so smitten by the incredibly cool way these things look that she asked me to return them to the living room after testing, so she can listen to them on a regular basis (unbelievable!).

Before I start dissecting the Zero 1s' sonics, let me make two things clear. First, while the Zero 1s sounded far, far better than any speaker had any right to do in the totally untreated space of my living room, all speakers—including horns—will perform more optimally in a room that, either inherently or by design, has a judicious mix of damped and "live" surfaces. Second, though the Avantgarde Zero 1s have been DSP'd to sound amplitude/impulse/phase-correct within a spacious listening bubble, their response is not intended to be further tailored to a given room via the DSP built into the speakers or by an outboard DSP unit—nor does Avantgarde encourage users to try this. In Avantgarde's opinions such manipulations will only screw up an already painstakingly optimized sound, and whatever "gains" may be heard in certain areas will most certainly be traded off against profound losses in others.

SPECS & PRICING

Type: Three-way active, digitally optimized floorstanding loudspeaker with horn-loaded tweeter, horn-loaded midrange, and dynamic bass

Subwoofer frequency response: 30Hz-250Hz

Midrange horn frequency response: 250Hz-2kHz

Tweeter horn frequency response: 2kHz- 20kHz

Sensitivity: >104dB

Inputs: USB, TosLink, SPDIF, AES/EBU, analog (optional)

Digital processing: 6 channel, 66-bit FPGA up to 100dB/octave; progressive FIR filters; three 24-bit Burr-Brown DACs

Amplification: Two 50W Class A, one 400W Class D

Dimensions: 490 x 1040 x 318 mm

Weight: 30 kg (per speaker)

Price: \$16,000

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JV's Reference System

Loudspeakers: Raidho D-5, Raidho D-1, Avantgarde Zero 1, MartinLogan CLX, Magnepan 1.7, Magnepan 3.7, Magnepan 20.7

Linestage preamps: Soulution 520, Constellation Virgo, Audio Research Reference 10, Siltech SAGA System C1, Zanden 3100

Phonostage preamps: Audio Research Corporation Reference Phono 10, Innovative Cohesion Engineering Raptor, Soulution 520, Zanden 120

Power amplifiers: Soulution 711, Siltech SAGA System V1/P1, Constellation Centaur, Audio Research Reference 250, Lamm ML2.2, Zanden 8120

Analog source: Walker Audio Proscenium Black Diamond Mk V, TW Acoustic Black Knight, AMG Viella 12

Tape deck: United Home Audio UHA-Q Phase 11S OPS

Phono cartridges: Clearaudio Goldfinger Statement, Ortofon MC A90, Ortofon MC Anna, Benz LP S-MR

Digital source: Berkeley Alpha DAC 2

Cable and interconnect: Synergistic Research Galileo LE, Crystal Cable Absolute Dream, Anzuz Diamond

Power Cords: Synergistic Research Galileo LE, Crystal Cable Absolute Dream, Anzuz Diamond

Power Conditioner: Synergistics Research Galileo LE, Technical Brain

Accessories: Synergistic ART and HFT/FEQ system, Shakti Hallographs (6), Zanden room treatment, A/V Room Services Metu panels and traps, ASC Tube Traps, Critical Mass MAXXUM equipment and amp stands, Symposium Isis and Ultra equipment platforms, Symposium Rollerblocks and Fat Padz, Walker Prologue Reference equipment and amp stands, Walker Valid Points and Resonance Control discs, Clearaudio Double Matrix SE record cleaner, Synergistic Research RED Quantum fuses, HiFi-Tuning silver/gold fuses